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DATA SHEET

TEA1097
Speech and loudspeaker amplifier IC with auxiliary inputs/outputs and analog multiplexer

Product specification
Supersedes data of 1998 Jun 11
File under Integrated Circuits, IC03

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Philips Semiconductors

PHILIPS

Speech and loudspeaker amplifier IC with auxiliary inputs/outputs and analog multiplexer

TEA1097

FEATURES

Line interface

- Low DC line voltage
- Voltage regulator with adjustable DC voltage
- Symmetrical high-impedance inputs (70 kΩ) for dynamic, magnetic or electric microphones
- Dual Tone Multi-Frequency (DTMF) input with confidence tone on earphone and/or loudspeaker
- Receive amplifier for dynamic, magnetic or piezo-electric earpieces (with externally adjustable gain)
- Automatic Gain Control (AGC) for true line loss compensation.

Supplies

- Provides a strong 3.35 V regulated supply for microcontroller or dialler
- Provides filtered power supply, optimized according to line current and compatible with external voltage or current sources
- Filtered 2 V power supply output for electret microphone
- Compatible with a ringer mode
- Power-Down ($\overline{PD}$) logic input for power-down.

Loudspeaker amplifier

- Single-ended rail-to-rail output
- Externally adjustable gain
- Dynamic limiter to prevent distortion
- Logarithmic volume control via linear potentiometer.

Auxiliary interfaces

- Asymmetrical high-impedance input for electret microphone.
- General purpose auxiliary output for transmit and receive
- Auxiliary transmit input with high signal level capability dedicated to line transmission
- Auxiliary receive input with high signal level capability
- Integrated multiplexer for channels selection.

APPLICATIONS

- Telephone answering machines
- Telephones with digital handsfree
- Line powered telephone sets
- Cordless telephones
- Fax machines.

GENERAL DESCRIPTION

The TEA1097 is an analog bipolar circuit dedicated for telephone applications. It includes a line interface, handset microphone and earpiece amplifiers, base microphone and loudspeaker amplifiers, some specific auxiliary Inputs/Outputs (I/Os) and an analog multiplexer to enable the right transmit and/or receive channels. The multiplexer is controlled by a logic circuitry decoding four logic inputs provided by a microcontroller. Twelve different application modes have been defined and can be accessed by selecting the right logic inputs.

This IC can be supplied by the line and/or by the mains if available (in a cordless telephone or a telephone answering machine for example). It provides a 3.35 V supply for a microcontroller or dialler and a 2 V filtered voltage supply for electret microphones. The IC is designed to facilitate the use of the loudspeaker amplifier during ringing phase.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TEA1097TV	VSO40	plastic very small outline package; 40 leads	SOT158-1
TEA1097H	QFP44	plastic quad flat package; 44 leads (lead length 1.3 mm); body $10 \times 10 \times 1.75$ mm	SOT307-2

QUICK REFERENCE DATA

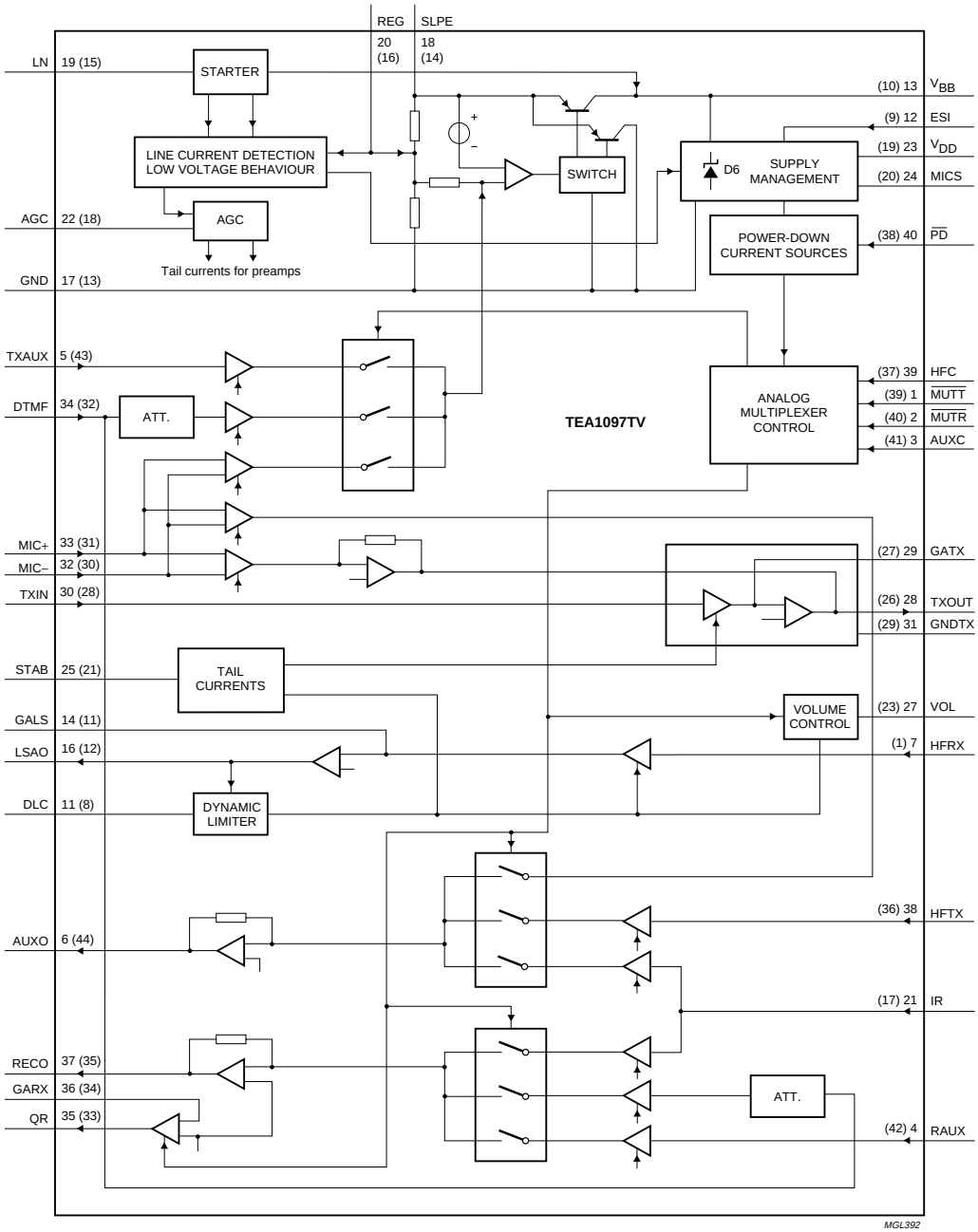
I_{line} = 15 mA; R_{SLPE} = 20 Ω; Z_{line} = 600 Ω; f = 1 kHz; T_{amb} = 25 °C; AGC pin connected to LN; $\overline{PD}$ = HIGH; HFC = LOW; AUXC = LOW; $\overline{MUTT}$ = HIGH; $\overline{MUTR}$ = HIGH; measured according to test circuits; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{line}	line current operating range	normal operation				
		TEA1097H	11	–	140	mA
		TEA1097TV	11	–	130	mA
		with reduced performance	1	–	11	mA
V_{SLPE}	stabilized voltage between SLPE and GND (V_{ref})	I_{line} = 15 mA	3.4	3.7	4.0	V
		I_{line} = 70 mA	5.7	6.1	6.5	V
V_{BB}	regulated supply voltage for internal circuitry	I_{line} = 15 mA	2.75	3.0	3.25	V
		I_{line} = 70 mA	4.9	5.3	5.7	V
V_{DD}	regulated supply voltage on pin V_{DD}	V_{BB} > 3.35 V + 0.25 V (typ.)	3.1	3.35	3.6	V
		otherwise	–	V_{BB} – 0.25	–	V
$V_{ESI(ext)}$	external voltage supply allowed on pin ESI		–	–	6	V
$I_{ESI(ext)}$	external current supply allowed on pin ESI		–	–	140	mA
I_{BB}	current available on pin V_{BB}	speech mode	–	11	–	mA
		handsfree mode; HFC = HIGH	–	9.5	–	mA
$I_{BB(pd)}$	current consumption on V_{BB} during power-down phase	$\overline{PD}$ = LOW	–	460	–	µA
$G_{v(MIC-LN)}$	voltage gain from pin MIC+/MIC– to LN	V_{MIC} = 5 mV (RMS)	43.3	44.3	45.3	dB
$G_{v(IR-RECO)}$	voltage gain from pin IR (referenced to LN) to RECO	V_{IR} = 15 mV (RMS)	28.7	29.7	30.7	dB
$\Delta G_{v(QR)}$	gain voltage range between pins RECO and QR		–3	–	+15	dB
$G_{v(TXIN-TXOUT)}$	voltage gain from pin TXIN to TXOUT	V_{TXIN} = 3 mV (RMS); R_{GATX} = 30.1 kΩ; note 1	13.15	14.85	16.55	dB
$G_{v(TXAUX-LN)}$	voltage gain from pin TXAUX to LN	V_{TXAUX} = 0.1 V (RMS); note 1	11.5	12.5	13.5	dB
$G_{v(HFRX-LSAO)}$	voltage gain from pin HFRX to LSAO	V_{HFRX} = 20 mV (RMS); R_{GALS} = 255 kΩ; note 1	25.5	28	30.5	dB
$\Delta G_{v(trx)}$	gain control range for transmit and receive amplifiers affected by the AGC; with respect to I_{line} = 15 mA	I_{line} = 70 mA; on $G_{v(MIC-LN)}$, $G_{v(IR-RECO)}$ and $G_{v(IR-AUXO)}$	5.45	6.45	7.45	dB

Note

1. When the channel is enabled according to Table 1.

BLOCK DIAGRAM



The pin numbers given in parenthesis refer to the TEA1097H.

Fig.1 Block diagram.

PINNING

SYMBOL	PIN		DESCRIPTION
	VSO40	QFP44	
$\overline{MUTT}$	1	39	logic input (active LOW)
$\overline{MUTR}$	2	40	logic input (active LOW)
AUXC	3	41	logic input
RAUX	4	42	auxiliary receive amplifier input
TXAUX	5	43	auxiliary transmit amplifier input
AUXO	6	44	auxiliary amplifier output
HFRX	7	1	receive input for loudspeaker amplifier
n.c.	8 to 10, 15 and 26	2 to 7, 22, 24 and 25	not connected
DLC	11	8	dynamic limiter capacitor for the loudspeaker amplifier
ESI	12	9	external supply input
V_{BB}	13	10	stabilized supply for internal circuitry
GALS	14	11	loudspeaker amplifier gain adjustment
LSAO	16	12	loudspeaker amplifier output
GND	17	13	ground reference
SLPE	18	14	line current sense
LN	19	15	positive line terminal
REG	20	16	line voltage regulator decoupling
IR	21	17	receive amplifier input
AGC	22	18	automatic gain control/line loss compensation
V_{DD}	23	19	3.35 V regulated voltage supply for microcontroller
MICS	24	20	microphone supply output
STAB	25	21	reference current adjustment
VOL	27	23	loudspeaker volume adjustment
TXOUT	28	26	base microphone amplifier output
GATX	29	27	base microphone amplifier gain adjustment
TXIN	30	28	base microphone amplifier input
GNDTX	31	29	ground reference for microphone amplifiers
MIC–	32	30	negative handset microphone amplifier input
MIC+	33	31	positive handset microphone amplifier input
DTMF	34	32	dual tone multi-frequency input
QR	35	33	earpiece amplifier output
GARX	36	34	earpiece amplifier gain adjustment
RECO	37	35	receive amplifier output
HFTX	38	36	transmit input for auxiliary receive amplifier
HFC	39	37	logic input
$\overline{PD}$	40	38	power-down input (active LOW)

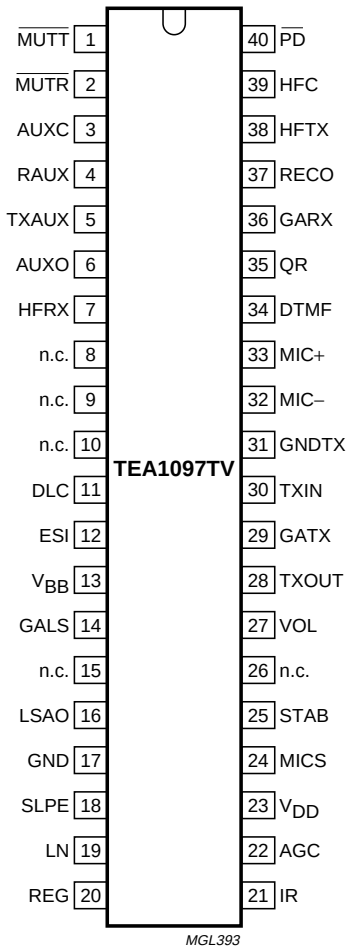


Fig.2 Pin configuration (VSO40).

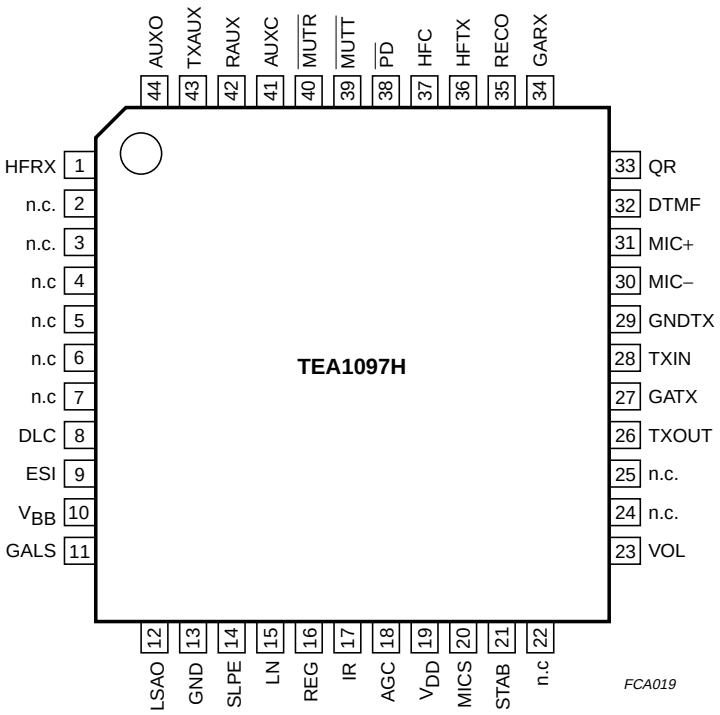


Fig.3 Pin configuration (QFP44).

FUNCTIONAL DESCRIPTION

All data given in this chapter are typical values, except when otherwise specified.

Supplies

LINE INTERFACE AND INTERNAL SUPPLY (PINS LN, SLPE, REG AND V_{BB})

The supply for the TEA1097 and its peripherals is obtained from the line. The IC generates a stabilized reference voltage (V_{ref}) between pins SLPE and GND. This reference voltage is equal to 3.7 V for line currents lower than 18 mA. It than increases linearly with the line current and reaches the value of 6.1 V for line currents higher than 45 mA. For line currents below 9 mA, the internal reference voltage generating V_{ref} is automatically adjusted to a lower value. This is the so-called low voltage area and the TEA1097 has limited performances in this area (see Section “Low voltage behaviour”). This reference voltage is temperature compensated.

The voltage between pins SLPE and REG is used by the internal regulator to generate the stabilized reference voltage and is decoupled by means of a capacitor between pins LN and REG.

This capacitor converted into an equivalent inductance realizes the set impedance conversion from its DC value (R_{SLPE}) to its AC value (done by an external impedance).

The IC regulates the line voltage at pin LN and it can be calculated as follows:

$$V_{LN} = V_{ref} + R_{SLPE} \times I_{SLPE}$$

$$I_{SLPE} = I_{line} - I^{x}$$

where:

I_{line} = line current

I^{x} = current consumed on pin LN (approximately a few μA)

I_{SLPE} = current flowing through the R_{SLPE} resistor.

The preferred value for R_{SLPE} is 20 Ω. Changing this value will affect more than the DC characteristics; it also influences the transmit gains to the line, the gain control characteristic, the sidetone level and the maximum output swing on the line.

As can be seen from Fig.4, the internal circuitry is supplied by pin V_{BB}, which is a strong supply point combined with the line interface. The line current is flowing through the R_{SLPE} resistor and is sunk by the V_{BB} voltage stabilizer, becoming available for a loudspeaker amplifier or any peripheral IC. Its voltage is equal to 3.0 V for line currents lower than 18 mA. It than increases linearly with the line current and reaches the value of 5.3 V for line currents greater than 45 mA. It is temperature compensated.

The aim of the current switch TR1 and TR2 is to reduce distortion of large AC line signals. Current I_{SLPE} is supplied to V_{BB} via TR1 when the voltage on SLPE is greater than V_{BB} + 0.25 V. When the voltage on SLPE is lower than this value, the current I_{SLPE} is shunted to GND via TR2.

The reference voltage V_{ref} can be increased by connecting an external resistor between pins REG and SLPE. For large line currents, this increase can slightly affect some dynamic performances such as maximum signal level on the line for 2% THD. The voltage on pin V_{BB} is not affected by this external resistor. See Fig.5 for the main DC voltages.

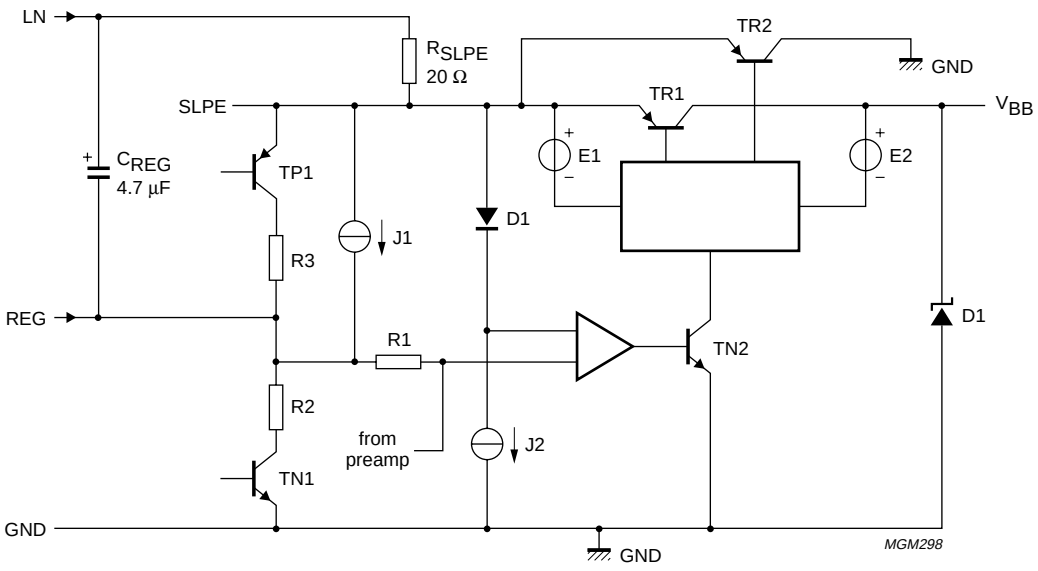


Fig.4 Line interface principle.

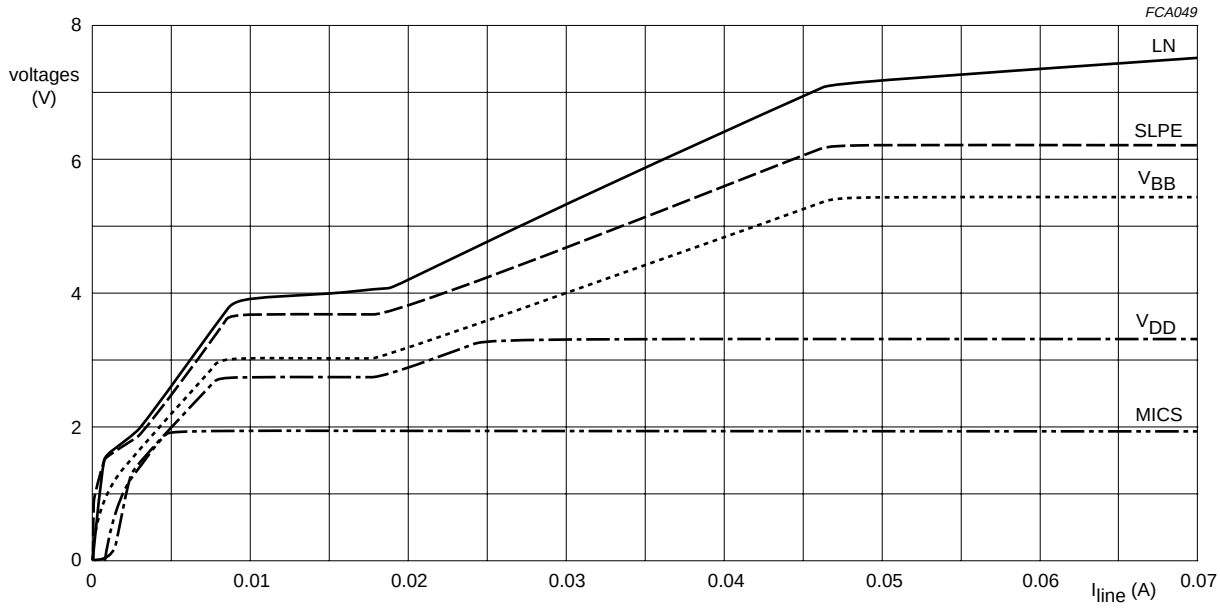


Fig.5 Main DC voltages as a function of line current.

EXTERNAL SUPPLY (PINS ESI AND V_{BB})

The TEA1097 can be supplied by the line as well as by external power sources (voltage or current sources) that must be connected to pin ESI.

The IC will choose which supply to use according to the voltage it can provide. A voltage supply on ESI is efficient only if its value is greater than the working voltage of the internal V_{BB} voltage stabilizer. Otherwise the IC continues to be line powered. The current consumed on this source is at least equal to the internal consumption. It depends on the voltage difference between the value forced on ESI and the working voltage of the internal stabilizer.
The current required increases with the voltage difference to manage. The excess current compared to the internal consumption becomes then available for other purposes such as supplying a loudspeaker amplifier. The voltage source should not exceed 6 V. If the value of the external voltage source can be lower than the working voltage of the internal stabilizer, an external diode is required to avoid reverse current flowing into the external power supply.

In case of current source, the voltage on V_{BB} and ESI depends on the current available. It is internally limited to 6.6 V. The current source should not exceed 140 mA.

V_{DD} SUPPLY FOR MICROCONTROLLERS (PIN V_{DD})

The voltage on V_{DD} supply point follows the voltage on V_{BB} with a difference equal to 250 mV (typ.) and is internally limited to 3.35 V. This voltage is temperature compensated. This supply point can provide a current up to 3 mA (typ.). Its internal consumption stays low (a few 10 nA) as long as V_{DD} does not exceed 1.5 V (see Fig.6).

An external voltage can be connected on V_{DD} with limited extra consumption on V_{DD} (typically 100 μA). This voltage source should not be lower than 3.5 V and higher than 6 V.

V_{BB} and V_{DD} can supply external circuits in the limits of currents provided either from the line or from pin ESI, taking into account the internal current consumption.

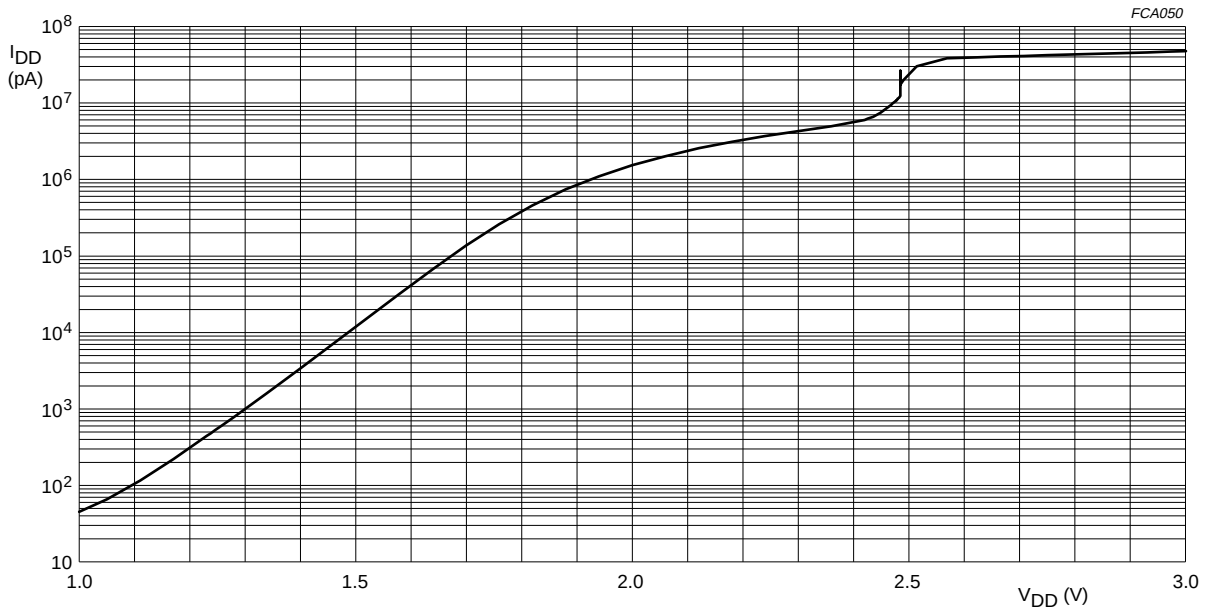


Fig.6 Current consumption on V_{DD}.

SUPPLY FOR MICROPHONE (PINS MICS AND GNDTX)

The MICS output can be used as a supply for an electret microphone. Its voltage is equal to 2 V; it can source current up to 1 mA and has an output impedance equal to 200 Ω.

LOW VOLTAGE BEHAVIOUR

For line currents below 9 mA, the reference voltage is automatically adjusted to a lower value; the V_{BB} voltage follows the SLPE voltage with 250 mV difference. The excess current available for other purposes than DC biasing of the IC becomes small. In this low voltage area, the IC has limited performances.

When the V_{BB} voltage reaches 2.7 V, the V_{BB} detector of the receive dynamic limiter on pin LSAO acts continuously, discharging the capacitor at pin DLC. In the DC condition, the loudspeaker is automatically disabled below this voltage.

When V_{BB} becomes lower than 2.5 V, the TEA1097 is forced in a low voltage mode whatever the levels on the logic inputs are. It is a speech mode with reduced performances only enabling the microphone channel (between the MIC inputs and LN) and the earpiece amplifier. These two channels are able to deliver signals for line currents as small as 3 mA. The HFC input is tied to GND sinking a current equal to 300 μA (typ.).

POWER-DOWN MODE (PINS $\overline{PD}$ AND AUXC)

To reduce current consumption during dialling or register recall (flash), the TEA1097 is provided with a power-down input ($\overline{PD}$). When the voltage on pins $\overline{PD}$ and AUXC is LOW, the current consumption from V_{BB} and V_{DD} is reduced to 460 μA (typ.). Therefore a capacitor of 470 μF connected to pin V_{BB} is sufficient to power the TEA1097 during pulse dialling or flash. The $\overline{PD}$ input has a pull-up structure, while AUXC has a pull-down structure. In this mode, the capacitor C_{REG} is internally disconnected.

RINGER MODE (PINS ESI, V_{BB}, AUXC AND $\overline{PD}$)

The TEA1097 is designed to be activated during the ringing phase. The loudspeaker amplifier can be used for the melody signal. The IC must be powered by an external supply on pin ESI, while applying a HIGH level on the logic input AUXC and a LOW level on the $\overline{PD}$ input. Only the HFRX input and the LSAO output are activated, in order to limit the current consumption. Some dynamic limiting is provided to prevent V_{BB} from being discharged below 2.7 V.

Transmit channels (pins MIC+, MIC–, DTMF, TXAUX and LN)

HANDSET MICROPHONE AMPLIFIER (PINS MIC+, MIC– AND LN)

The TEA1097 has symmetrical microphone inputs. The input impedance between MIC+ and MIC– is 70 kΩ (typ.). The voltage gain between pins MIC+, MIC– and LN is set to 44.3 dB. Without limitation from the output, the microphone input stage can accommodate signals up to 18 mV (RMS) at room temperature for 2% of THD. The microphone inputs are biased at one diode voltage.

Automatic gain control is provided for line loss compensation.

DTMF AMPLIFIER (PINS DTMF, LN AND RECO)

The TEA1097 has an asymmetrical DTMF input. The input impedance between pin DTMF and GND is 20 kΩ (typ.). The voltage gain between pins DTMF and LN is set to 25.35 dB. Without limitation from the output, the input stage can accommodate signals up to 180 mV (RMS) at room temperature for 2% of THD.

When the DTMF amplifier is enabled, dialling tones may be sent on the line. These tones can be heard in the earpiece or in the loudspeaker at a low level. This is called the confidence tone. The voltage attenuation between pins DTMF and RECO is typically equal to −16.5 dB.

The DC biasing of this input is 0 V.

The automatic gain control has no effect on these channels.

AUXILIARY TRANSMIT AMPLIFIER (PINS TXAUX AND LN)

The TEA1097 has an asymmetrical auxiliary input TXAUX. The input impedance between pins TXAUX and GND is 20 kΩ (typ.). The voltage gain between pins TXAUX and LN is set to 12.5 dB. Without limitation from the output, the input stage can accommodate signals up to 1.2 V (RMS) at room temperature for 2% of THD. The TXAUX input is biased at two diodes voltage.

Automatic gain control is provided for line loss compensation.

MICROPHONE MONITORING ON TXOUT (PINS MIC+, MIC– AND TXOUT)

The voltage gain between the microphone inputs MIC+, MIC– and the output TXOUT is set to 49.8 dB. This channel gives an image of the signal sent on the line while speaking in the handset microphone. Using external circuitry, this signal can be used for several purposes such as sending dynamic limiting or anti-howling in a listening-in application. The TXOUT output is biased at two diodes voltage.

The automatic gain control has no effect on these channels.

Receive channels (pins IR, RAUX, RECO, GARX and QR)

RX AMPLIFIER (PINS IR AND RECO)

The receive amplifier has one input IR which is referred to the line. The input impedance between pins IR and LN is 20 kΩ (typ.) and the DC biasing between these pins is equal to one diode voltage. The gain between pins IR (referenced to LN) and RECO is typically equal to 29.7 dB. Without limitation from the output, the input stage can accommodate signals up to 50 mV (RMS) at room temperature for 2% of THD.

This receive amplifier has a rail-to-rail output RECO, which is designed for use with high-ohmic (real) loads (larger than 5 kΩ). This output is biased at two diodes voltage.

Automatic gain control is provided for line loss compensation.

EARPIECE AMPLIFIER (PINS GARX AND QR)

The earpiece amplifier is an operational amplifier having its output (QR) and its inverting input (GARX) available. Its input signal comes, via a decoupling capacitor, from the receive RECO output. It is used in combination with two resistors to get the required gain or attenuation compared to the receive gain. It can be chosen between −3 and +15 dB.

Two external capacitors C_{GAR} (connected between pins GARX and QR) and C_{GARS} (connected between pins GARX and GND) ensure stability. The C_{GAR} capacitor provides a first-order low-pass filter. The cut-off frequency corresponds to the time constant $C_{GAR} \times R_{e2}$.
The relationship $C_{GARS} \geq 10 \times C_{GAR}$ must be fulfilled.

The earpiece amplifier has a rail-to-rail output QR, biased at two diodes voltage. It is designed for use with low-ohmic (real) loads (150 Ω) or capacitive loads (100 nF in series with 100 Ω).

When the amplifier is turned off, the signal present on the earpiece is equal to the ratio between the load on QR and $R_{e1} + R_{e2}$

AUXILIARY RECEIVE AMPLIFIER (PINS RAUX AND RECO)

The auxiliary receive amplifier has an asymmetrical input RAUX; it uses the RECO output. Its input impedance between pins RAUX and GND is typically equal to 20 kΩ. The voltage gain between pins RAUX and RECO is equal to −2.4 dB. Without any limitation from the output, the input stage can accommodate signals up to 0.95 V (RMS) at room temperature for 2% of THD.

This auxiliary amplifier has a rail-to-rail output RECO, which is designed for use with high ohmic (real) loads (larger than 5 kΩ). This output is biased at two diodes voltage.

The automatic gain control has no effect on this channel.

Auxiliary amplifiers using AUXO (pins MIC+, MIC−, HFTX, IR and AUXO)

The TEA1097 has an auxiliary output AUXO, biased at two diodes voltage. This output stage is a rail-to-rail one, designed for use with high-ohmic (real) loads (larger than 5 kΩ). The AUXO output amplifier is used in three different channels, two transmit channels and one receive channel.

AUXILIARY AMPLIFIERS USING THE MICROPHONE INPUTS (PINS MIC+, MIC− AND AUXO)

The auxiliary transmit amplifier using the microphone MIC+ and MIC− inputs has a gain of 25.5 dB referenced to AUXO. Without limitation from the output, the input stage can accommodate signals up to 16 mV (RMS) at room temperature for 2% of THD.

The automatic gain control has no effect on this channel.

AUXILIARY AMPLIFIERS USING HFTX (PINS HFTX AND AUXO)

The auxiliary transmit amplifier using the HFTX input has a gain of 15.2 dB referenced to AUXO.

The automatic gain control has no effect on this channel.

RX AMPLIFIER USING IR (PINS IR AND AUXO)

The auxiliary receive amplifier uses pin IR as input. The input is referenced to pin LN and the DC biasing between these two pins is one diode voltage. The voltage gain between the input IR (referenced to LN) and the output AUXO is typically equal to 32.8 dB, which compensates typically the attenuation provided by the anti-sidetone network.

Automatic gain control is provided for line loss compensation.

Automatic gain control (pin AGC)

The TEA1097 performs automatic line loss compensation, which fits well with the true line attenuation. The automatic gain control varies the gain of some transmit and receive amplifiers in accordance with the DC line current.
The control range is 6.45 dB for $G_{v(MIC-LN)}$, $G_{v(IR-RECO)}$ and $G_{v(IR-AUXO)}$ and 6.8 dB for $G_{v(TXAUX-LN)}$, which corresponds approximately to a line length of 5.5 km for a 0.5 mm twisted-pair copper cable.

To enable this gain control, the pin AGC must be shorted to pin LN. The start current for compensation corresponds to a line current equal to typically 23 mA and the stop current to 57 mA. The start current can be increased by connecting an external resistor between pins AGC and LN. It can be increased to 40 mA (using a resistor typically equal to 80 kΩ). The start and stop current will be maintained in a ratio equal to 2.5. By leaving the AGC pin open-circuit, the gain control is disabled and no line loss compensation is performed.

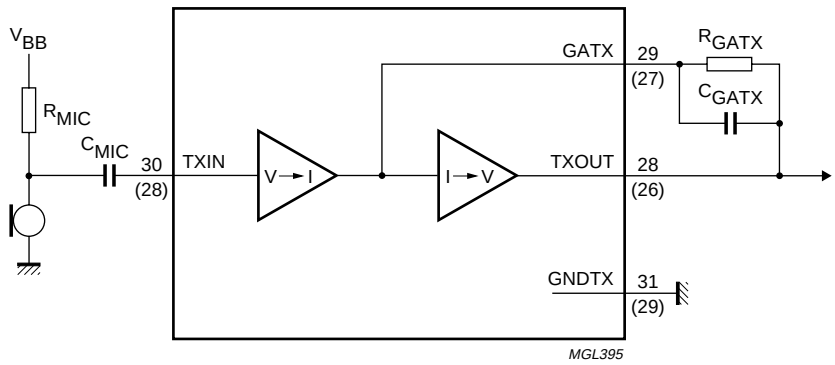
Base microphone channel (pins TXIN, GATX, TXOUT and GNDTX) see Fig.7

The TEA1097 has an asymmetrical base microphone input TXIN with an input resistance of 20 kΩ.
The DC biasing of the input is 0 V.

The output TXOUT is biased at two diodes voltage and has a current capability equal to 20 μA (RMS). The gain of the microphone amplifier (from pins TXIN to TXOUT) can be adjusted from 0 to 31 dB to suit specific application requirements.

The gain is proportional to the value of R_{GATX} and equals 14.85 dB with R_{GATX} = 30.1 kΩ. Without limitation from the output, the microphone input stage can accommodate signals up to 18 mV (RMS) at room temperature for 2% of THD.

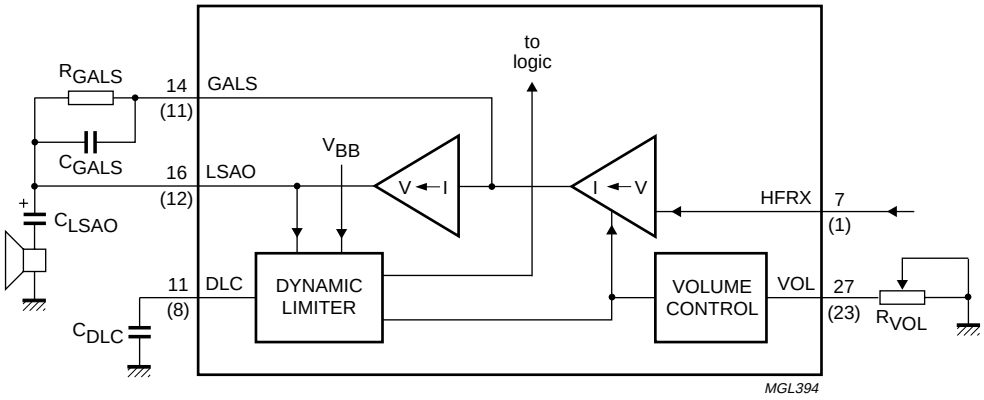
A capacitor can be connected in parallel with R_{GATX} to provide a 1st-order low-pass filter.



The pin numbers given in parenthesis refer to the TEA1097H.

Fig.7 Base microphone channel.

Loudspeaker channel



The pin numbers given in parenthesis refer to the TEA1097H.

Fig.8 Loudspeaker channel.

LOUDSPEAKER AMPLIFIER: PINS HFRX, GALS AND LSAO

The TEA1097 has an asymmetrical input for the loudspeaker amplifier with an input resistance of 20 kΩ between pins HFRX and GND. It is biased at two diodes voltage. The input stage can accommodate signals up to 580 mV (RMS) at room temperature for 2% of THD.

The rail-to-rail output stage is designed to power a loudspeaker down to 8 Ω connected as a single-ended load (between pins LSAO and GND). When the circuit is externally supplied, the maximum output power is equal to 280 mW (typ.) for 6 V applied to pin ESI.

The gain of the loudspeaker amplifier can be adjusted from 0 to 35 dB to suit specific application requirements. The gain from HFRX to LSAO is proportional to the value of R_{GALS} and equals 28 dB with R_{GALS} = 255 kΩ. A capacitor connected in parallel with R_{GALS} is recommended and provides a first-order low-pass filter.

VOLUME CONTROL (PIN VOL)

The loudspeaker amplifier gain can be adjusted with the potentiometer R_{VOL}. A linear potentiometer can be used to obtain logarithmic control of the gain at the loudspeaker amplifier. Each 1.9 kΩ increase of R_{VOL} results in a gain loss of 3 dB.

DYNAMIC LIMITER (PIN DLC)

The dynamic limiter of the TEA1097 prevents clipping of the loudspeaker output stage and protects the operation of the circuit when the supply voltage at V_{BB} falls below 2.7 V.

Hard clipping of the loudspeaker output stage is prevented by rapidly reducing the gain when the output stage starts to saturate. The time in which gain reduction is effected (clipping attack time) is approximately a few milliseconds. The circuit stays in the reduced gain mode until the peaks of the loudspeaker signals no longer cause saturation. The gain of the loudspeaker amplifier then returns to its normal value within the clipping release time (typically 100 ms). Both attack and release times are proportional to the value of the capacitor C_{DLC}. The total harmonic distortion of the loudspeaker output stage, in reduced gain mode, stays below 1% up to 10 dB (min.) of input voltage overdrive [providing V_{HFRX} is below 580 mV (RMS)].

When the supply voltage drops below an internal threshold voltage of 2.7 V, the gain of the loudspeaker amplifier is rapidly reduced (approximately 1 ms). When the supply voltage exceeds 2.7 V, the gain of the loudspeaker amplifier is increased again. By forcing a level lower than 0.2 V on pin DLC, the loudspeaker amplifier is muted.

Logic inputs

Table 1 Selection of transmit and receive channels for 12 different application modes

LOGIC INPUTS					FEATURES	APPLICATION EXAMPLES
$\overline{PD}$	HFC	$\overline{MUTT}$	$\overline{MUTR}$	AUXC		
0	X	X	X	1	HFRX to LSAO	ringer mode
0	X	X	X	0		flash, DC dialling
1	0	0	0	0	DTMF to LN; DTMF to RECO; QR and MICS are active	DTMF dialling in handset
1	0	0	1	0	MIC to AUXO; RAUX to RECO; QR and MICS are active	cordless intercom with corded handset
1	0	1	1	0	MIC to LN; IR to RECO; IR to AUXO; MIC to TXOUT; QR and MICS are active	handset conversation
1	0	1	0	1	TXAUX to LN and IR to AUXO	conversation using auxiliary I/O; cordless: digital handsfree in mobile
1	1	0	1	1	RAUX to RECO and HFRX to LSAO	listening on the loudspeaker
1	1	0	0	1	TXAUX to LN; IR to AUXO; RAUX to RECO; HFRX to LSAO	answering machine: play and record messages; listen the recorded message on the loudspeaker
1	1	0	0	0	DTMF to LN; DTMF to RECO; HFRX to LSAO; QR and MICS are active	DTMF dialling in handsfree or group listening modes
1	1	1	0	1	TXAUX to LN; IR to AUXO; IR to RECO and HFRX to LSAO	answering machine: play and record messages while listening in the loudspeaker
1	1	0	1	0	TXIN to TXOUT; HFTX to AUXO; RAUX to RECO; HFRX to LSAO and MICS is active	cordless intercom with base
1	1	1	1	0	TXIN to TXOUT; TXAUX to LN; IR to RECO; IR to AUXO; HFRX to LSAO; MICS is active	digital handsfree conversation
1	1	1	0	0	MIC to LN; IR to RECO; IR to AUXO; HFRX to LSAO; MIC to TXOUT; QR and MICS are active	handset conversation with group-listening

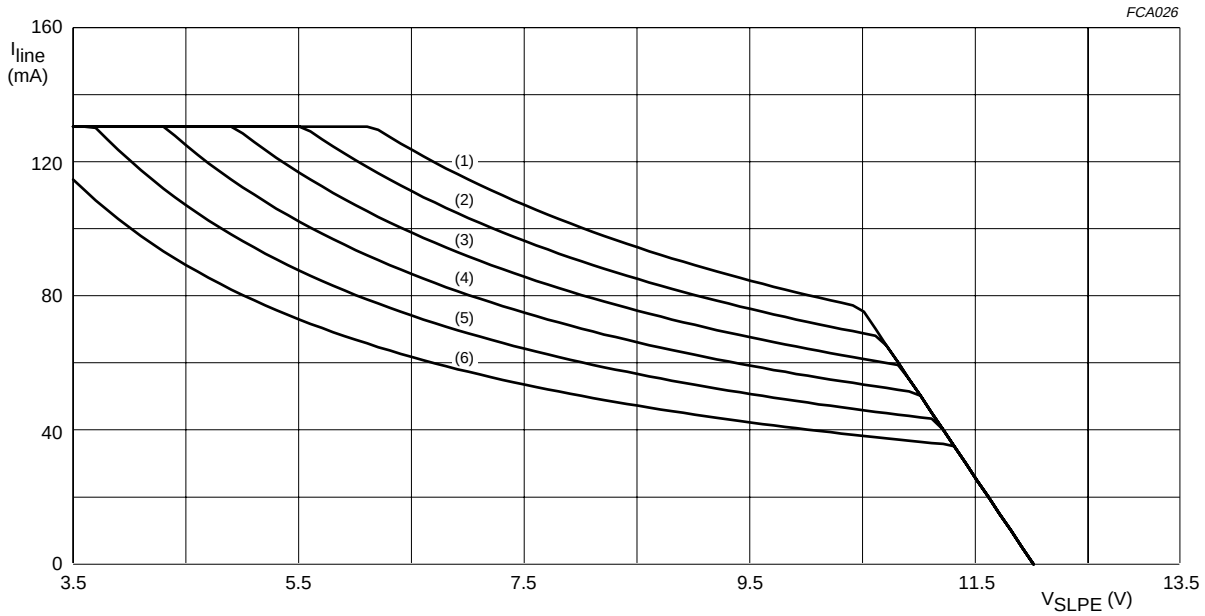
LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134); DC levels are referenced to GND.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{LN}	positive continuous line voltage		–0.4	+12	V
	repetitive line voltage during switch-on or line interruption		–0.4	+13.2	V
V_{ESI}	positive continuous voltage on pin ESI		–0.4	+6	V
$I_{i(ESI)}$	input current at pin ESI		–	140	mA
$V_{n(max)}$	maximum voltage				
	on pins REG, SLPE, IR and AGC		–0.4	V_{LN} + 0.4	V
	on all other pins except V_{DD}		–0.4	V_{BB} + 0.4	V
I_{line}	maximum line current for				
	TEA1097H		–	140	mA
	TEA1097TV		–	130	mA
P_{tot}	total power dissipation	T_{amb} = 75 °C			
	TEA1097TV		–	400	mW
	TEA1097H		–	720	mW
T_{stg}	IC storage temperature		–40	+125	°C
T_{amb}	operating ambient temperature		–25	+75	°C

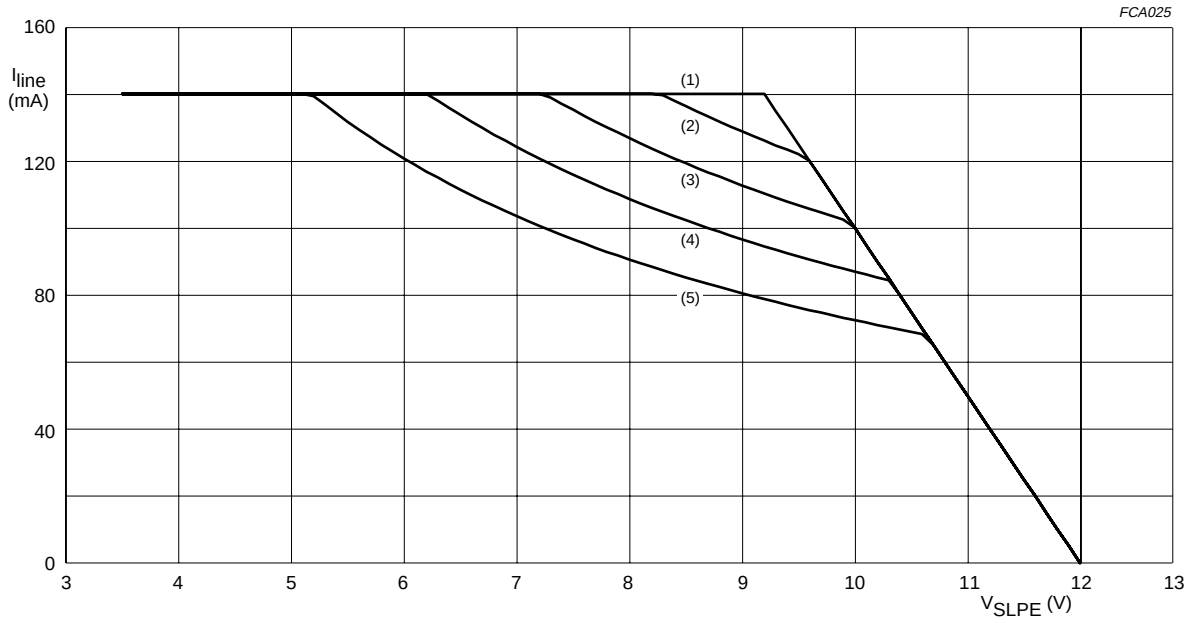
THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air		
	TEA1097TV		115	K/W
	TEA1097H		63	K/W



LINE	T_{amb} (°C)	P_{tot} (mW)
(1)	25	800
(2)	35	720
(3)	45	640
(4)	55	560
(5)	65	480
(6)	75	400

Fig.9 Safe operating area (TEA1097TV).



LINE	T_{amb} (°C)	P_{tot} (mW)
(1)	35	1304
(2)	45	1158
(3)	55	1012
(4)	65	866
(5)	75	720

Fig.10 Safe operating area (TEA1097H).

CHARACTERISTICS

I_{line} = 15 mA; R_{SLPE} = 20 Ω; Z_{line} = 600 Ω; f = 1 kHz; T_{amb} = 25 °C; AGC pin connected to LN; $\overline{PD}$ = HIGH; HFC = LOW; AUXC = LOW; $\overline{MUTT}$ = HIGH; $\overline{MUTR}$ = HIGH; measured according to test circuits; DC levels are referenced to GND; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supplies						
LINE INTERFACE AND INTERNAL SUPPLY (PINS LN, SLPE, REG AND V_{BB})						
V_{SLPE}	stabilized voltage between SLPE and GND (V_{ref})	I_{line} = 15 mA	3.4	3.7	4	V
		I_{line} = 70 mA	5.7	6.1	6.5	V
V_{BB}	regulated supply voltage for internal circuitry	I_{line} = 15 mA	2.75	3.0	3.25	V
		I_{line} = 70 mA	4.9	5.3	5.7	V
I_{line}	line current for voltage increase	start current	–	18	–	mA
		stop current	–	45	–	mA
$\Delta V_{SLPE(T)}$	stabilized voltage variation with temperature referenced to 25 °C	T_{amb} = −25 to +75 °C	–	±60	–	mV
$\Delta V_{BB(T)}$	regulated voltage variation with temperature referenced to 25 °C	T_{amb} = −25 to +75 °C	–	±30	–	mV
I_{BB}	current available on pin V_{BB}	speech mode	–	11	–	mA
		digital handsfree mode; HFC = HIGH	–	9.5	–	mA
V_{LN}	line voltage	I_{line} = 1 mA	–	1.55	–	V
		I_{line} = 4 mA	–	2.35	–	V
		I_{line} = 15 mA	3.7	4.0	4.3	V
		I_{line} = 130 mA	–	8.7	9.3	V
EXTERNAL SUPPLY (PIN ESI)						
V_{ESI}	external voltage supply allowed on pin ESI		–	–	6	V
	voltage on pin ESI when supplied by a current source	I_{ESI} = 140 mA except in power-down mode	–	6.6	–	V
$I_{i(ESI)}$	input current on pin ESI	V_{ESI} = 3.5 V	–	3.1	–	mA
$I_{ESI(ext)}$	external current supply allowed on pin ESI		–	–	140	mA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
SUPPLY FOR PERIPHERALS (PIN V_{DD})						
V_{DD}	regulated supply voltage on V_{DD}	V_{BB} > 3.35 V + 0.25 V (typ.)	3.1	3.35	3.6	V
		otherwise	–	V_{BB} – 0.25	–	V
$\Delta V_{DD(T)}$	regulated voltage variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C; V_{BB} > 3.35 V + 0.25 V (typ.)	–	±30	–	mV
I_{DD}	current consumption on V_{DD}	in trickle mode; I_{line} = 0 mA; V_{DD} = 1.5 V; V_{BB} discharging	–	15	150	nA
		V_{DD} > 3.35 V	60	100	–	µA
$I_{DD(o)}$	current available for peripherals	V_{DD} = 3.35 V	–	–	–3	mA
SUPPLY FOR MICROPHONE (PIN MICS)						
V_{MICS}	supply voltage for a microphone		–	2	–	V
I_{MICS}	current available on MICS		–	–	–1	mA
POWER-DOWN INPUT (PIN $\overline{PD}$)						
V_{IL}	LOW-level input voltage		–0.4	–	+0.3	V
V_{IH}	HIGH-level input voltage		1.8	–	V_{BB} + 0.4	V
$I_{i(pd)}$	input current		–	–3	–6	µA
$I_{BB(pd)}$	current consumption on V_{BB} during power-down phase	$\overline{PD}$ = LOW; AUXC = LOW	–	460	–	µA
RINGER MODE (PINS $\overline{PD}$, AUXC, HFRX AND LSAO)						
$I_{i(ESI)}$	input current on pin ESI	$\overline{PD}$ = LOW; AUXC = HIGH; V_{ESI} = 3.5 V	–	3.1	–	mA
$G_{v(HFRX-LSAO)}$	voltage gain from pin HFRX to LSAO	$\overline{PD}$ = LOW; AUXC = HIGH; V_{ESI} = 3.5 V; V_{HFRX} = 20 mV (RMS); R_{GALS} = 255 kΩ	–	28	–	dB
Preamplifier inputs (pins MIC+, MIC–, IR, DTMF, TXIN, HFTX, HFRX, TXAUX and RAUX)						
$\lvert Z_{i(MIC)} \rvert$	input impedance					
	differential between pins MIC+ and MIC–		–	70	–	kΩ
	single-ended between pins MIC+/MIC– and GNDTX		–	35	–	kΩ
$\lvert Z_{i(IR)} \rvert$	input impedance between pins IR and LN		–	20	–	kΩ
$\lvert Z_{i(DTMF)} \rvert$	input impedance between pins DTMF and GND		–	20	–	kΩ
$\lvert Z_{i(TXIN)} \rvert$	input impedance between pins TXIN and GNDTX		–	20	–	kΩ

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$\lvert Z_{i(HFTX)} \rvert$	input impedance between pins HFTX and GND		–	20	–	kΩ
$\lvert Z_{i(HFRX)} \rvert$	input impedance between pins HFRX and GND		–	20	–	kΩ
$\lvert Z_{i(TXAUX)} \rvert$	input impedance between pins TXAUX and GND		–	20	–	kΩ
$\lvert Z_{i(RAUX)} \rvert$	input impedance between pins RAUX and GND		–	20	–	kΩ
TX amplifiers; see note 1						
TX HANDSET MICROPHONE AMPLIFIER (PINS MIC+, MIC– AND LN)						
$G_{v(MIC-LN)}$	voltage gain from pin MIC+/MIC– to LN	V_{MIC} = 5 mV (RMS)	43.3	44.3	45.3	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.25	–	dB
CMRR	common mode rejection ratio		–	80	–	dB
THD	total harmonic distortion at pin LN	V_{LN} = 1.4 V (RMS)	–	–	2	%
		I_{line} = 4 mA; V_{LN} = 0.12 V (RMS)	–	–	10	%
$V_{no(LN)}$	noise output voltage at pin LN; pins MIC+/MIC– shorted through 200 Ω	psophometrically weighted (p53 curve)	–	–77.5	–	dBmp
$\Delta G_{v(mute)}$	gain reduction if not activated	$\overline{HFC}$ = LOW; $\overline{MUTT}$ = LOW; $\overline{MUTR}$ = LOW; AUXC = LOW	60	80	–	dB
DTMF AMPLIFIER (PINS DTMF, LN AND RECO)						
$G_{v(DTMF-LN)}$	voltage gain from pin DTMF to LN	V_{DTMF} = 50 mV (RMS)	24.35	25.35	26.35	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.25	–	dB
$\Delta G_{v(mute)}$	gain reduction if not activated	$\overline{HFC}$ = LOW; $\overline{MUTT}$ = HIGH; $\overline{MUTR}$ = HIGH; AUXC = LOW	60	80	–	dB
$G_{v(DTMF-RECO)}$	voltage gain from pin DTMF to RECO	V_{DTMF} = 50 mV (RMS)	–	–16.5	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
TX AUXILIARY AMPLIFIER USING TXAUX (PINS TXAUX AND LN)						
$G_{v(TXAUX-LN)}$	voltage gain from pin TXAUX to LN	V_{TXAUX} = 0.1 V (RMS)	11.5	12.5	13.5	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.25	–	dB
THD	total harmonic distortion at LN	V_{LN} = 1.4 V (RMS)	–	–	2	%
$V_{TXAUX(rms)}$	maximum input voltage at TXAUX (RMS value)	I_{line} = 70 mA; THD = 2%	–	1.2	–	V
$V_{no(LN)}$	noise output voltage at pin LN; pin TXAUX shorted to GND through 200 Ω in series with 10 μF	psophometrically weighted (p53 curve)	–	–80.5	–	dBmp
$\Delta G_{v(mute)}$	gain reduction if not activated	$\overline{HFC}$ = LOW; $\overline{MUTT}$ = LOW; $\overline{MUTR}$ = LOW; AUXC = LOW	60	80	–	dB
MICROPHONE MONITORING ON TXOUT (PINS MIC+, MIC– AND TXOUT)						
$G_{v(MIC-TXOUT)}$	voltage gain from pin MIC+/MIC– to TXOUT	V_{MIC} = 2 mV (RMS)	48.3	49.8	51.3	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.1	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.35	–	dB
RX amplifiers; see note 1						
RX AMPLIFIERS USING IR (PINS IR AND RECO)						
$G_{v(IR-RECO)}$	voltage gain from pin IR (referenced to LN) to RECO	V_{IR} = 15 mV (RMS)	28.7	29.7	30.7	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.3	–	dB
$V_{IR(rms)(max)}$	maximum input voltage on IR (referenced to LN) (RMS value)	I_{line} = 70 mA; THD = 2%	–	50	–	mV
$V_{RECO(rms)(max)}$	maximum output voltage on pin RECO (RMS value)	THD = 2%	0.75	0.9	–	V
$V_{no(RECO)(rms)}$	noise output voltage at pin RECO; pin IR is an open-circuit (RMS value)	psophometrically weighted (p53 curve)	–	–88	–	dBVp
$\Delta G_{v(mute)}$	gain reduction if not activated	$\overline{HFC}$ = LOW; $\overline{MUTT}$ = LOW; $\overline{MUTR}$ = LOW; AUXC = LOW	60	80	–	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
RX EARPIECE AMPLIFIER (PINS GARX AND QR)						
$\Delta G_{v(RECO-QR)}$	gain voltage range between pins RECO and QR		–3	–	+15	dB
$V_{QR(rms)(max)}$	maximum output voltage on pin QR (RMS value)	sine wave drive; R_L = 150 Ω; THD < 2%	0.75	0.9	–	V
$V_{no(QR)(rms)}$	noise output voltage at pin QR; pin IR is an open-circuit (RMS value)	$G_{v(QR)}$ = 0 dB; psophometrically weighted (p53 curve)	–	–88	–	dBVp
RX AMPLIFIER USING RAUX (PINS RAUX AND RECO)						
$G_{v(RAUX-RECO)}$	voltage gain from pin RAUX to RECO	V_{RAUX} = 0.4 V (RMS)	–3.7	–2.4	–1.1	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.25	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.25	–	dB
$V_{RAUX(rms)(max)}$	maximum input voltage on RAUX (RMS value)	THD = 2%	–	0.95	–	V
$V_{no(RECO)(rms)}$	noise output voltage at pin RECO; pin RAUX shorted to GND through 200 Ω in series with 10 μF (RMS value)	psophometrically weighted (p53 curve)	–	–100	–	dBVp
$\Delta G_{v(mute)}$	gain reduction if not activated	$\overline{HFC}$ = LOW; $\overline{MUTT}$ = LOW; $\overline{MUTR}$ = LOW; AUXC = LOW	60	80	–	dB
Auxiliary amplifiers using AUXO; see note 1						
TX AUXILIARY AMPLIFIER USING MIC+ AND MIC– (PINS MIC+, MIC– AND AUXO)						
$G_{v(MIC-AUXO)}$	voltage gain from pin MIC+/MIC– to AUXO	V_{MIC} = 10 mV (RMS)	24.2	25.5	26.8	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.1	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.3	–	dB
$V_{MIC(rms)}$	maximum input voltage on MIC+/MIC– (RMS value)	THD = 2%	–	16	–	mV
$V_{no(AUXO)(rms)}$	noise output voltage at pin AUXO; pins MIC+/MIC– shorted to GNDTX through 200 Ω in series with 10 μF (RMS value)	psophometrically weighted (p53 curve)	–	–91	–	dBVp

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
TX AUXILIARY AMPLIFIER USING HFTX (PINS HFTX AND AUXO)						
$G_{v(HFTX-AUXO)}$	voltage gain from pin HFTX to AUXO	V_{HFTX} = 100 mV (RMS)	14.2	15.2	16.2	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.1	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.1	–	dB
$V_{AUXO(rms)}$	maximum output voltage on pin AUXO (RMS value)	THD = 2%	0.8	0.9	–	V
$V_{no(AUXO)(rms)}$	noise output voltage at pin AUXO; pin HFTX shorted to GND through 200 Ω in series with 10 μF (RMS value)	psophometrically weighted (p53 curve)	–	–91.5	–	dBVp
$\Delta G_{v(mute)}$	gain reduction if not activated	$\overline{HFC}$ = LOW; $\overline{MUTT}$ = LOW; $\overline{MUTR}$ = HIGH; AUXC = LOW	60	80	–	dB
RX AMPLIFIER USING IR (PINS IR AND AUXO)						
$G_{v(IR-AUXO)}$	voltage gain from pin IR (referenced to LN) to AUXO	V_{IR} = 3 mV (RMS)	31.6	32.8	34	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.1	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.3	–	dB
$V_{AUXO(rms)}$	maximum output voltage on AUXO (RMS value)	THD = 2%	0.8	0.9	–	V
$V_{no(AUXO)(rms)}$	noise output voltage at pin AUXO; pin IR is an open-circuit (RMS value)	psophometrically weighted (p53 curve)	–	–85	–	dBVp
$\Delta G_{v(mute)}$	gain reduction if not activated	$\overline{HFC}$ = HIGH; $\overline{MUTT}$ = LOW; $\overline{MUTR}$ = HIGH; AUXC = HIGH	60	80	–	dB
Automatic Gain Control (pin AGC)						
$\Delta G_{v(trx)}$	gain control range for transmit and receive amplifiers affected by the AGC; with respect to I_{line} = 15 mA	I_{line} = 70 mA; on $G_{v(MIC-LN)}$, $G_{v(IR-RECO)}$ and $G_{v(IR-AUXO)}$	5.45	6.45	7.45	dB
		I_{line} = 70 mA; $G_{v(TXAUX-LN)}$	5.8	6.8	7.8	dB
I_{start}	highest line current for maximum gain		–	23	–	mA
I_{stop}	lowest line current for maximum gain		–	57	–	mA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Logic inputs (pins HFC, AUXC, $\overline{\text{MUTT}}$ and $\overline{\text{MUTR}}$)						
V_{IL}	LOW-level input voltage		–0.4	–	+0.3	V
V_{IH}	HIGH-level input voltage		1.8	–	V_{BB} + 0.4	V
I_i	input current					
	for pins HFC and AUXC		–	3	6	µA
	for pins $\overline{\text{MUTT}}$ and $\overline{\text{MUTR}}$		–	–2.5	–6	µA
Base microphone amplifier (pins TXIN, TXOUT and GATX); see note 1						
$G_{v(TXIN-TXOUT)}$	voltage gain from pin TXIN to TXOUT	V_{TXIN} = 3 mV (RMS); R_{GATX} = 30.1 kΩ	13.15	14.85	16.55	dB
ΔG_v	voltage gain adjustment with R_{GATX}		–15	–	+16	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.1	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.15	–	dB
$V_{no(TXOUT)(rms)}$	noise output voltage at pin TXOUT; pin TXIN is shorted through 200 Ω in series with 10 µF to GNDTX (RMS value)	psophometrically weighted (p53 curve)	–	–101	–	dBVp
$\Delta G_{v(mute)}$	gain reduction if not activated	$\overline{\text{HFC}}$ = HIGH; $\overline{\text{MUTT}}$ = LOW; $\overline{\text{MUTR}}$ = LOW; AUXC = LOW	60	80	–	dB
Loudspeaker amplifier (pins HFRX, LSAO, GALS and VOL); see note 1						
$G_{v(HFRX-LSAO)}$	voltage gain from pin HFRX to LSAO	V_{HFRX} = 20 mV (RMS); R_{GALS} = 255 kΩ	25.5	28	30.5	dB
ΔG_v	voltage gain adjustment with R_{GALS}		–28	–	+7	dB
$\Delta G_{v(f)}$	gain variation with frequency referenced to 1 kHz	f = 300 to 3400 Hz	–	±0.3	–	dB
$\Delta G_{v(T)}$	gain variation with temperature referenced to 25 °C	T_{amb} = –25 to +75 °C	–	±0.3	–	dB
$\Delta G_{v(vol)}$	voltage gain variation related to ΔR_{VOL} = 1.9 kΩ		–	–3	–	dB
$V_{(HFRX)(rms)(max)}$	maximum input voltage at pin HFRX (RMS value)	I_{line} = 70 mA; R_{GALS} = 33 kΩ; for 2% THD in the input stage	–	580	–	mV
$V_{no(LSAO)(rms)}$	noise output voltage at pin LSAO; pin HFRX is open-circuit (RMS value)	psophometrically weighted (p53 curve)	–	–79	–	dBVp
$V_{LSAO(rms)}$	output voltage (RMS value) without external supply on pin ESI	I_{BB} = 0 mA; I_{DD} = 1 mA				
		I_{line} = 18 mA	–	0.9	–	V
		I_{line} = 30 mA	–	1.2	–	V
		I_{line} > 50 mA	–	1.6	–	V

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{LSAO(max)}$	maximum output current at pin LSAO (peak value)	external supply on ESI	150	300	–	mA
Dynamic limiter (pins LSAO and DLC); see note 1						
t_{att}	attack time	when V_{HFRX} jumps from 20 mV to 20 mV + 10 dB	–	–	5	ms
		when V_{BB} jumps below $V_{BB(th)}$	–	1	–	ms
t_{rel}	release time	when V_{HFRX} jumps from 20 mV + 10 dB to 20 mV	–	100	–	ms
THD	total harmonic distortion at V_{HFRX} = 20 mV + 10 dB	$t > t_{att}$	–	0.1	2	%
$V_{BB(th)}$	V_{BB} limiter threshold		–	2.7	–	V
Mute Loudspeaker (pin DLC); see note 1						
$V_{DLC(th)}$	threshold voltage required on pin DLC to obtain mute receive condition		–0.4	–	+0.2	V
$I_{DLC(th)}$	threshold current sourced by pin DLC in mute receive condition	V_{DLC} = 0.2 V	–	100	–	μA
$\Delta G_{vrx(mute)}$	voltage gain reduction in mute receive condition	V_{DLC} = 0.2 V	60	80	–	dB

Note

1. When the channel is enabled according to Table 1.

TEST AND APPLICATION INFORMATION

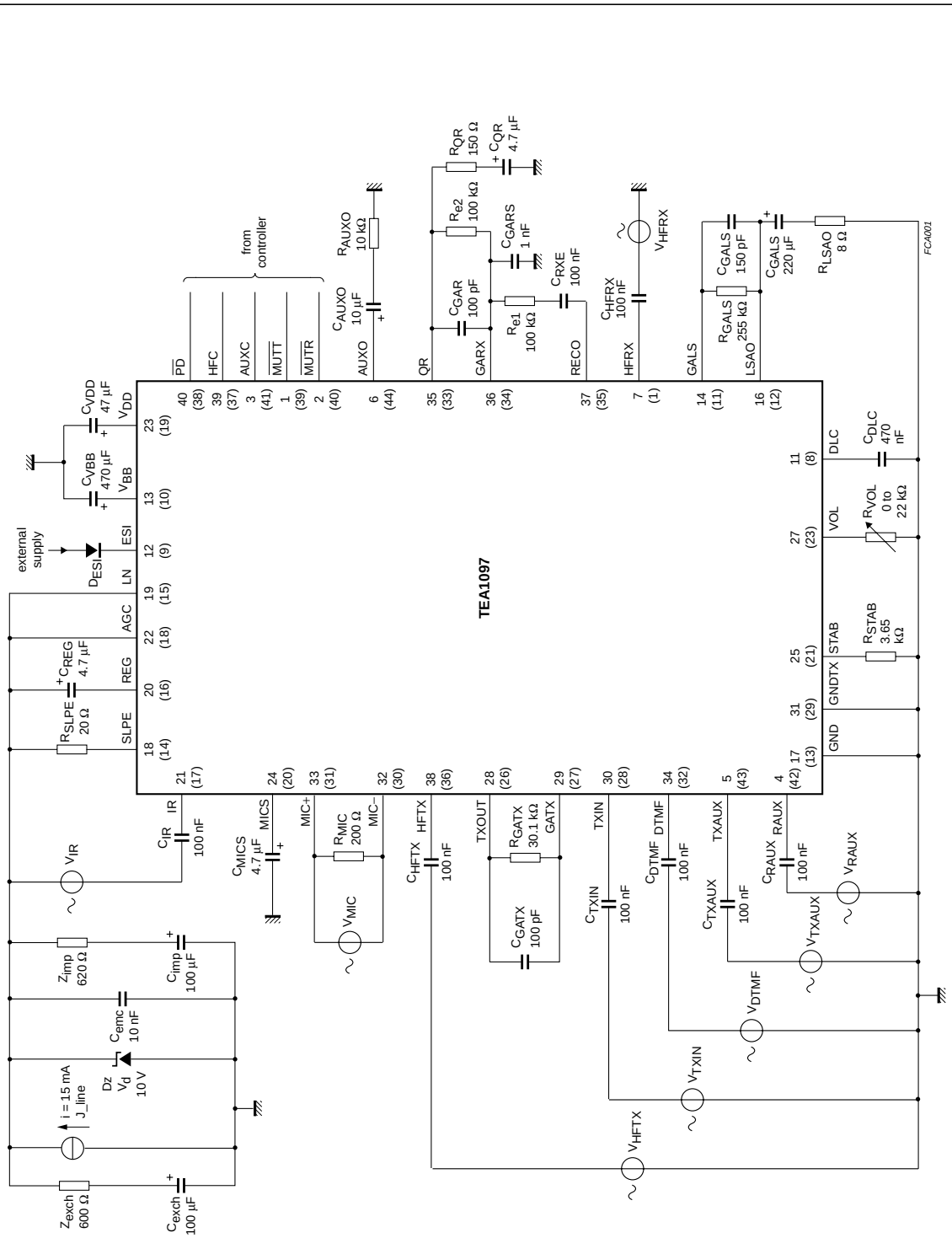


Fig.11 Test circuit.

The pin numbers given in parenthesis refer to the TEA1097H.

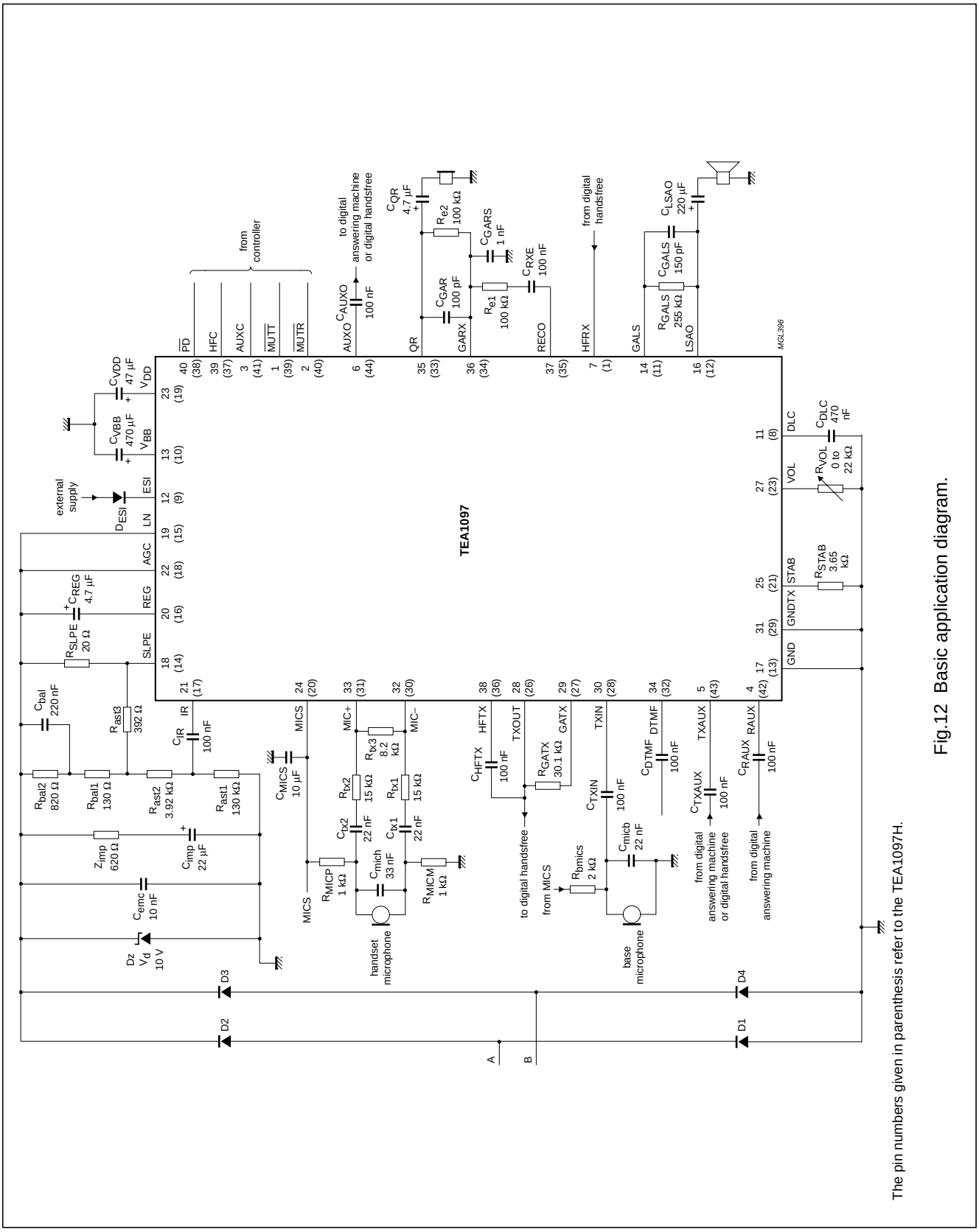
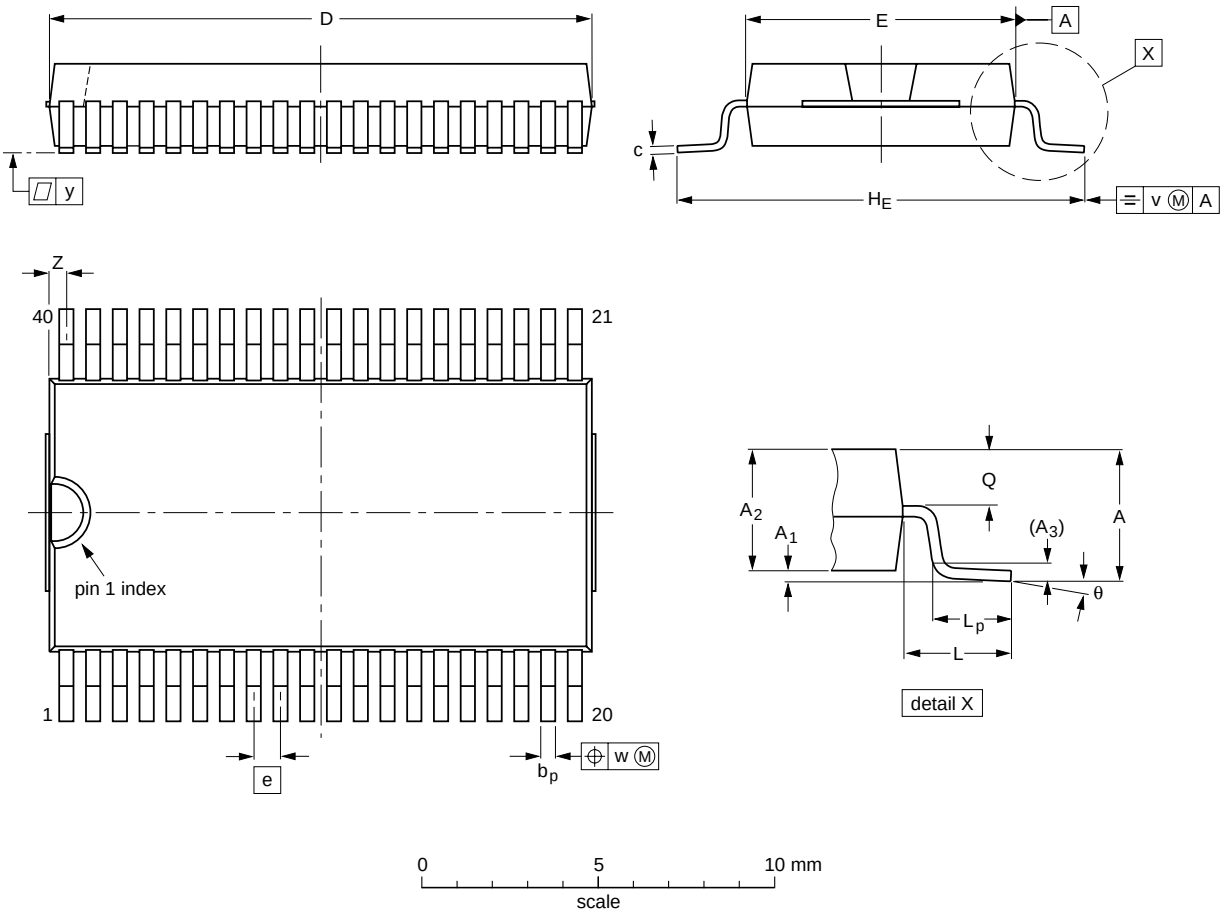


Fig.12 Basic application diagram.

The pin numbers given in parenthesis refer to the TEA1097H.

PACKAGE OUTLINES

VSO40: plastic very small outline package; 40 leads **SOT158-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

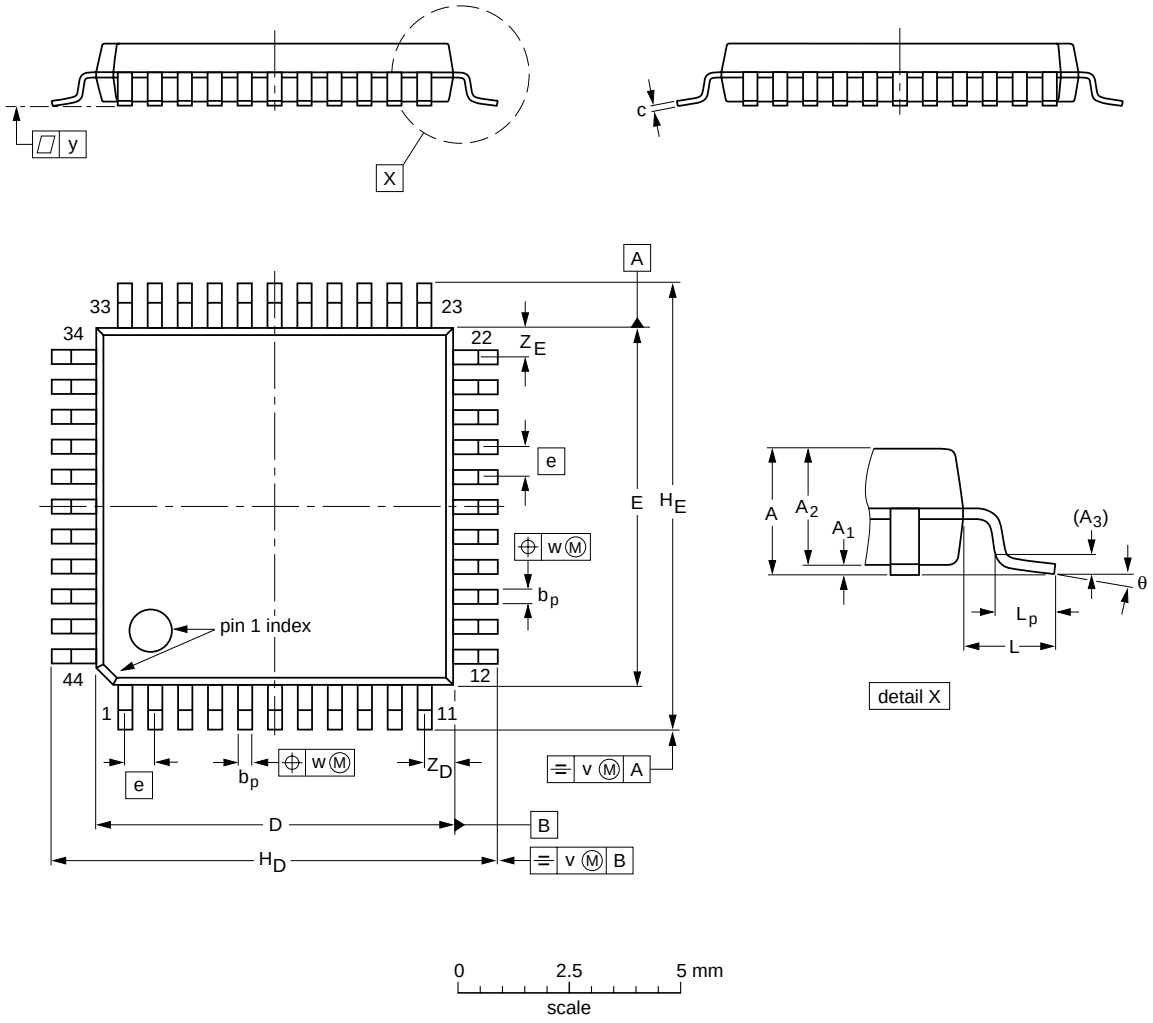
UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(2)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	2.70	0.3 0.1	2.45 2.25	0.25	0.42 0.30	0.22 0.14	15.6 15.2	7.6 7.5	0.762	12.3 11.8	2.25	1.7 1.5	1.15 1.05	0.2	0.1	0.1	0.6 0.3	7^o 0^o
inches	0.11	0.012 0.004	0.096 0.089	0.010	0.017 0.012	0.0087 0.0055	0.61 0.60	0.30 0.29	0.03	0.48 0.46	0.089	0.067 0.059	0.045 0.041	0.008	0.004	0.004	0.024 0.012	

Notes

1. Plastic or metal protrusions of 0.4 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT158-1						~~92-11-17~~ 95-01-24

QFP44: plastic quad flat package; 44 leads (lead length 1.3 mm); body 10 x 10 x 1.75 mm **SOT307-2**



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_D	H_E	L	L_p	v	w	y	$Z_D^{(1)}$	$Z_E^{(1)}$	θ
mm	2.10	0.25 0.05	1.85 1.65	0.25	0.40 0.20	0.25 0.14	10.1 9.9	10.1 9.9	0.8	12.9 12.3	12.9 12.3	1.3	0.95 0.55	0.15	0.15	0.1	1.2 0.8	1.2 0.8	10^o 0^o

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT307-2						~~95-02-04~~ 97-08-01

SOLDERING

Introduction to soldering surface mount packages

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

Reflow soldering

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferable be kept below 230 °C.

Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
  - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
  - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

  The footprint must incorporate solder thieves at the downstream end.
- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Typical dwell time is 4 seconds at 250 °C.
A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

Suitability of surface mount IC packages for wave and reflow soldering methods

PACKAGE	SOLDERING METHOD	
	WAVE	REFLOW(1)
BGA, SQFP	not suitable	suitable
HLQFP, HSQFP, HSOP, HTSSOP, SMS	not suitable(2)	suitable
PLCC(3), SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended(3)(4)	suitable
SSOP, TSSOP, VSO	not recommended(5)	suitable

Notes

1. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the *"Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods"*.
2. These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
3. If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
4. Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
5. Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

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Philips Semiconductors – a worldwide company

Argentina: see South America

Australia: 34 Waterloo Road, NORTH RYDE, NSW 2113,
Tel. +61 2 9805 4455, Fax. +61 2 9805 4466

Austria: Computerstr. 6, A-1101 WIEN, P.O. Box 213,
Tel. +43 1 60 101 1248, Fax. +43 1 60 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 20 0733, Fax. +375 172 20 0773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 68 9211, Fax. +359 2 68 9102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381, Fax. +1 800 943 0087

China/Hong Kong: 501 Hong Kong Industrial Technology Centre,
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,
Tel. +852 2319 7888, Fax. +852 2319 7700

Colombia: see South America

Czech Republic: see Austria

Denmark: Sydhavnsgade 23, 1780 COPENHAGEN V,
Tel. +45 33 29 3333, Fax. +45 33 29 3905

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615 800, Fax. +358 9 6158 0920

France: 51 Rue Carnot, BP317, 92156 SURESNES Cedex,
Tel. +33 1 4099 6161, Fax. +33 1 4099 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 2353 60, Fax. +49 40 2353 6300

Hungary: see Austria

India: Philips INDIA Ltd, Band Box Building, 2nd floor,
254-D, Dr. Annie Besant Road, Worli, MUMBAI 400 025,
Tel. +91 22 493 8541, Fax. +91 22 493 0966

Indonesia: PT Philips Development Corporation, Semiconductors Division,
Gedung Philips, Jl. Buncit Raya Kav.99-100, JAKARTA 12510,
Tel. +62 21 794 0040 ext. 2501, Fax. +62 21 794 0080

Ireland: Newstead, Clonskeagh, DUBLIN 14,
Tel. +353 1 7640 000, Fax. +353 1 7640 200

Israel: RAPAC Electronics, 7 Kehilat Saloniki St, PO Box 18053,
TEL AVIV 61180, Tel. +972 3 645 0444, Fax. +972 3 649 1007

Italy: PHILIPS SEMICONDUCTORS, Piazza IV Novembre 3,
20124 MILANO, Tel. +39 2 6752 2531, Fax. +39 2 6752 2557

Japan: Philips Bldg 13-37, Kohnan 2-chome, Minato-ku,
TOKYO 108-8507, Tel. +81 3 3740 5130, Fax. +81 3 3740 5077

Korea: Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,
Tel. +82 2 709 1412, Fax. +82 2 709 1415

Malaysia: No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR,
Tel. +60 3 750 5214, Fax. +60 3 757 4880

Mexico: 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,
Tel. +9-5 800 234 7381, Fax +9-5 800 943 0087

Middle East: see Italy

Netherlands: Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,
Tel. +31 40 27 82785, Fax. +31 40 27 88399

New Zealand: 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,
Tel. +64 9 849 4160, Fax. +64 9 849 7811

Norway: Box 1, Manglerud 0612, OSLO,
Tel. +47 22 74 8000, Fax. +47 22 74 8341

Pakistan: see Singapore

Philippines: Philips Semiconductors Philippines Inc.,
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,
Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

Poland: Ul. Lukiska 10, PL 04-123 WARSZAWA,
Tel. +48 22 612 2831, Fax. +48 22 612 2327

Portugal: see Spain

Romania: see Italy

Russia: Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,
Tel. +7 095 755 6918, Fax. +7 095 755 6919

Singapore: Lorong 1, Toa Payoh, SINGAPORE 319762,
Tel. +65 350 2538, Fax. +65 251 6500

Slovakia: see Austria

Slovenia: see Italy

South Africa: S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale,
2092 JOHANNESBURG, P.O. Box 7430 Johannesburg 2000,
Tel. +27 11 470 5911, Fax. +27 11 470 5494

South America: Al. Vicente Pinzon, 173, 6th floor,
04547-130 SÃO PAULO, SP, Brazil,
Tel. +55 11 821 2333, Fax. +55 11 821 2382

Spain: Balmes 22, 08007 BARCELONA,
Tel. +34 93 301 6312, Fax. +34 93 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 5985 2000, Fax. +46 8 5985 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2741 Fax. +41 1 488 3263

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2886, Fax. +886 2 2134 2874

Thailand: PHILIPS ELECTRONICS (THAILAND) Ltd.,
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,
Tel. +66 2 745 4090, Fax. +66 2 398 0793

Turkey: Talatpasa Cad. No. 5, 80640 GÜLTEPE/ISTANBUL,
Tel. +90 212 279 2770, Fax. +90 212 282 6707

Ukraine: PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7,
252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

United Kingdom: Philips Semiconductors Ltd., 276 Bath Road, Hayes,
MIDDLESEX UB3 5BX, Tel. +44 181 730 5000, Fax. +44 181 754 8421

United States: 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,
Tel. +1 800 234 7381, Fax. +1 800 943 0087

Uruguay: see South America

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Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 62 5344, Fax.+381 11 63 5777

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International Marketing & Sales Communications, Building BE-p, P.O. Box 218,
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